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THE EVENING PRIMROSE IN RELATION TO INSECTS*

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There is a mutual interdependence of insects and plants in which both may be benefited, or if one is injured, the resulting benefit is so great in comparison with the injury that it does not impair the value of the relation. There is also a dependence in which the insect alone benefits and the plant suffers all the injury. Many insects depend entirely upon plants for their very existence and contribute nothing in return. The plant tissue furnishes them food and possibly shelter. However, the amount and character of the injury may vary considerably and be either a serious check to growth or a negligible happening in the life of the plant.

The number of insect species supported by one kind of plant is often very large. Folsom[1] states that the horse-chestnut and buckeye have perhaps a dozen species, the elm eighty, the birches over one hundred, the pines over one hundred and seventy, while the oaks sustain certainly five hundred and probably twice as many more. The clover is affected by about two hundred species directly or indirectly, but grows vigorously and is able to withstand considerable injury. Corn harbors about two hundred species, fifty of which do serious injury, and apple supports some four hundred species. Some plants are almost free from attack, such as poison ivy, which is supposed to support only four species.

In this paper, the term "evening primrose" should be taken to mean those species commonly and incorrectly known as *Oenothera biennis*. The true *O. biennis* has not been found in America but is widely distributed in Europe. The Oenotheras are of American origin, but *biennis* has no known native American habitat as yet. They are usually dry soil plants, mostly biennial, making only a rosette during the first year. The following observations are the results of a year's study of primrose insects, mostly in New Jersey supplemented by the results of students in other parts of the United States.

The number of species of insects (excluding parasites) found to be associated either directly or indirectly with the evening primrose was over one hundred, a small number in comparison with the numbers affecting oaks but large in comparison with the numbers associated with many other plants and weeds. From the time the primrose appears above the ground until its death, it is more or less continuously infested, and even its dead dry stalks furnish shelter for some species. Beginning with the rosette stage, the leaves forming the head

*A complete account of the various insects associated with evening primrose appeared in the Journal of the New York Entomological Society, under the title, The Insects of the Evening Primroses in New Jersey by E. L. Dickerson and H. B. Weiss, vol. 28. No. 1, 1920.

1—Entomology with reference to its Biological and Economic Aspects, 1906.

serve as food for the larvae of a small, gaily colored moth *Phalonia oenotherana* Riley and hibernation quarters for the weevil *Tyloderma aerea* Say and undoubtedly other species of Coleoptera.

During the second year of its growth and in late spring when it is scarcely a foot high, the leaves are quite likely to harbor numerous plant lice. As it continues to grow, such beetles as *Haltica marevagans* Horn, *Haltica fuscoaenea* Mels., *Graphops pubescens* Mels., *Anomala lucicola, Epitrix cucumeris, Phyllotreta sinuata, Gymnetron teter* are found feeding on the foliage. Sometimes it is completely riddled by the first two species and their larvae which are flea beetles. The tip moth *Phalonia oenotherana* also reappears and infests the growing tip of the stalk. The stalk is further infested all summer by large numbers of *Tyloderma foveolata* larvae which are found for the most part in the lower portion while the entire remainder even to the extreme tip is very often channeled by the numerous larvae of another small moth known as *Mompha eloisella* Clem. In addition to the Coleoptera or beetle feeders noted above, the foliage is quite likely to support in addition, the larvae of the following Lepidoptera, *Desmia funeralis* Hubn., commonly known as a pest of grape, *Celerio lineata* Fabr., the White Lined Sphinx, which has a large list of food plants, *Apantesis arge* Dru., a corn feeder, *Euthisanotia unio* Hubn., *Eupithecia interruptofasciata* Pack., and *Sparganothis sulfureana* Clem.

When the flower buds appear they are eaten by the Lepidopterous larva of *Rhodophora florida*, this species boring a round hole in the bud of sufficient size to admit its head, which it sinks downward, feeding as it goes, on the folded floral parts. Two other Lepidopterous larvae, those of *Mompha stellella* Busck, and *Mompha murtfeldtella* Cham., feed within the bud on the immature floral parts, causing the bud to swell appreciably. In addition, the buds are likely to be infested by the larvae of the weevil *Acanthoscelis acephalus* Say.

When the seed capsules appear, their contents are usually partly eaten by such species as *Mompha circumscriptella* Zell, *and Mompha brevivittella* Clem., and late in the fall many are covered by plant lice. In a few cases, aphids are found on the roots. In addition to the species enumerated above, many other miscellaneous ones were found on the foliage and stem and in the blossoms. Some, such as lady-bird beetles and ants, were indirect associates being directly associated with the aphids. Others were possible feeders and accidental visitors. The following tables summarize the distribution and activities of primrose insects.

DISTRIBUTION OF PRIMROSE INSECT FEEDERS AND FLOWER VISITORS

	Number of species feeding on or in					Flower visitors.	Totals
	roots	stem	leaves	flower buds	seed capsules		
Homoptera	1		8				9
Hemiptera			1				1
Coleoptera		1	11	1			13
Lepidoptera		1	7	3	2	1	14
Hymenoptera			1			10	11
Diptera			1			1	2
Totals	1	2	29	4	2	12	50

ACTIVITIES OF ALL PRIMROSE INSECTS

	Known Feeders on or in during one or more stages.	Flower visitors	Found on foliage or stems. Some are probably feeders.	Totals
Homoptera	9		4	13
Hemiptera	1		15	16
Coleoptera	13		32	45
Lepidoptera	13	1		14
Hymenoptera*	1	10	9	20
Diptera*	1	1	2	4
Totals	38	12	62	112

*Parasites not included

Thus of a total of 111 species, 38 or over one third utilize the plants for food purposes, many of them being present at the same time and others succeeding each other throughout the growing season. Yet in spite of almost constant and in many cases severe infestations, the growth of the plant is hardly ever visibly impaired and the insect visitations appear to be negligible happenings in the life of the plant. In spite of the injury to the rosette, the main stalk shoots up the following season. In spite of being tunneled from base to tip, it produces branches and leaves which are in turn riddled by leaf feeders. Flowers are produced profusely in spite of the bud injury and while many seed capsules are damaged, plenty escape. Hundreds of plants infested in all degrees were examined and aside from a small amount of fasciation, a small amount of distortion and a slight stunting which may have been due to other causes, no apparent or serious setback in the growth was observed. Infested plants developed, flowered, produced seed and died more or less the same as uninfested plants. Under such conditions, the results to many plants other than primrose would probably be more or less fatal, but the primroses are evidently vigorous enough to outgrow the injuries of a host of insects.

NOTES ON NEW JERSEY HETEROCERA WITH DESCRIPTIONS OF ONE NEW SPECIES AND TWO NEW FORMS.

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During the summer of 1919 the writer spent almost every week end in the New Jersey Pine Barrens, mainly at Brown's Mills in the Pines. Besides many rarities, the following new forms and one new species were taken. The types of these were very carefully compared at the collection of Dr. William Barnes by the author, and in order to eliminate any chance of error, checked by Dr. A. W. Lindsey.

Eriopyga (Orthodes) lindseyi n. sp.

Head, thorax and ground color of the fore-wings concolorously reddish, with a tendency toward ochreous and with a strong satiny luster. Antennae simple, ciliated, cilia in block like pattern on basal segments, longer setae visible on apical segments. Prothorax with a small, spreading somewhat divided crest; metathorax with a very small divided crest, or at least a trace of one pro-

duced by hair tuftings. A few blackish scales tend to form a black line at the base of the prothoracic crest, and another on collar. Fore-wings with all lines double, and filled in with less reddish and more ochreous color than the ground, as are the reinforms and orbiculars. Subbasal line waved; transverse anterior waved; rather indistinct; orbicular small, round; reniform kidney shaped; two small white spots, one on each side of the reniform at its base, tending to become semi-confluent by the presence of a few white scales between them; transverse posterior line strongly outcurved from costa to vein 4, then incurved toward inner margin, slightly drawn out on the inner margin, thus forming a complete S; a suggestion of minute ochreous spots on some of the veins in the subterminal space, subterminal line oblique inwardly at costa, outwardly so in radial region, inwardly again in medial area, thus forming a rough reversed Z, below which it is evenly outcurved, finally projected to the inner margin as another outcurved scollop, a terminal row of minute black dots between the veins, which of themselves possess a scattering of black scales, fringe concolorous with the ground. Secondaries whitish with considerable fuscous shading; the terminal border marked by a thin, blackish line composed of elongated dots, fringe light at base and tips, a broad, dusky line through center; discoidal spot visible, probably mainly showing through from under side; veins somewhat dusky. Beneath: both wings whitish-fuscous, with discoidal spot and common line darker, dusky; a row of terminal spots between the veins on both wings; cell of fore-wing sparsely clothed with long hair. Sexes identical.

Type Locality: Brown's Mills in the Pines and 1 ♂ Overbrook, N. J.; also 2 ♂, 1 ♀, Barnes Coll., Pitman, N. J.

No. and Sexes of Types: Holotype ♂, Allotype ♀, 29 Paratypes ♂ ♀.

Dates of Capture: V, VII, IX.

Types in: Collection of Author, and Barnes; also 1 Paratype, U. S. N. M.

This insect to some extent resembles *vecors, irrorata, puerilis* and when badly rubbed—*furfurata*, but seems abundantly distinct. The vestiture is far more scaly than is typical for members of the group *Orthodes*, and the satiny luster to the wings more pronounced. The vestiture is so scaly that the insect might well be placed in the genus *Mamestra* (*Polia*) were it not for its general appearance, resemblance, and apparent close relationship in all other characters to described members of the group *Orthodes*.

Chytonix sensilis form **macdonaldi** form nov.

Sir George Hampson places *Chytonix sensilis* in that group of the genus *Chytonix* having simple antennae in the male sex. However, the Cat. Lep. Phal., B. M., seems to indicate that he did not know the male, which is similar to the female in pattern and maculation, but the antennae are laminate, the laminations almost forming short pectinations. Two males of the typical form were taken; and also one female without the white spot below the black streak connecting the transverse anterior and the transverse posterior lines in the submedian fold. This corresponds to ab. l. of Hampson. One male and two females lacked the black streak, and in these the white spot is completely diffused by mixing with a suffusion of whitish scaling in the medial area. The resulting insect scarcely resembles the typical form, and may henceforth be known

under the form name *macdonaldi*, in remembrance of the many nights in the Pine Barrens during which Neil F. MacDonald, B. Chem., assisted untiringly the work of the author.

The general condition of all the specimens of this form taken is none the best. The females are in better condition than the male, and hence one of these is designated the holotype. This specimen has the transverse anterior and transverse posterior lines spaced a little further apart on the inner margin than is typical of *C. sensilis*. The male allotype and female paratype are normal in this respect.

Type Locality: Brown's Mills in the Pines, N. J.

No. and sexes of Types: Holotype ♀, Allotype ♂, 1 Paratype ♀.

Types in: Collection of Author.

Olene atomaria form **aridensis** form nov.

Size, lines and ordinary spots similar to *O. atomaria*. Female: fore-wing; basal area filled in with chocolate-brown to the transverse anterior line; subterminal area similarly filled; the medial area pale, olivaceous, with tendencies to blueish in some specimens and greenish in others, more suffused with color basally and inwardly. This gives a general impression of *O cinnamomea*, but the size is larger and it matches in no other details. The reniform spot is strongly outlined with a fine chocolate-brown line, and is filled in paler than the pale medial area. As usual with species of this genus the basal edge of this spot is strongly marked. Hind wings an even medium brown with only the discal spot showing in some specimens, while in others a trace of a shade line is to be found. In this respect as well as in the peculiar coloration of the fore-wings, the form differs considerably from typical *O. atomaria*. Under side with discoidal spot, and shade line half way between spot and outer margin. Male: fore-wing with the basal area strongly tinged with purple; the subterminal area lighter brown than in the female, with a purplish and white patch on anal region; otherwise similar to the female, except that there is a waved line of the same color as the medial area through the basal brown area, thus cutting this into two parts. On the underside, the spots and lines are similar to the same ones in the female, but somewhat more suffused and broader, with the line on the fore-wing somewhat nearer to the spot.

This form is described mainly at the suggestion of Dr. William Barnes. At Brown's Mills in the Pines, N. J., *atomaria* runs to two forms; one much lighter than typical, more suffused, and with much less brown on the fore-wings. Of this form I have two specimens: ♂ ♀, the ♂ taken 31-VIII-19, the ♀ 5-VIII-19. The other form is described above.

Type Locality: Brown's Mills in the Pines, N. J.

No. and sexes of Types: Holotype ♀, Allotype ♂, Paratypes 11 ♀ ♀, also 1 egg from Holotype.

Dates of Capture: August.

Types in: Collection of Author; 2 Paratypes and egg, Collection of Cornell University, 2 Paratypes, Collection Wm. Barnes.

NOTES ON FUNGOUS INSECTS.

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The following notes on fungous insects have accumulated since the publication of former papers along this line.* Records not specifically credited were obtained by the writers.

In Entomological News Vol. XXX, No. 5, pp. 144—5, Mr. W. H. Wellhouse calls attention to *Mycodiplosis cerasifolia* (Dip.) feeding on the spores of Crataegus rust (*Gymnosporangium clavipes* C. and P.). Mr. Wellhouse found the larvae of this itonid living among the aeciospores and feeding upon them. Gravatt and Posey (Jour. Agric. Res. vol. 12, No. 7) state that "larvae of the gipsy moth (*Porthetria dispar*) feed on the peridermium stage of *Cronartium ribicola* and carry thousands of aeciospores on their bodies." They further state that the larvae feed abundantly on the spores and injure the fruiting layer of the postules so that further spore production is arrested.

In a letter Mr. Thos. E. Snyder informs us that the beetle *Cupes concolor* is usually found in the southeastern states in oak stumps upon which are growing the fruiting bodies of *Daedalia quercina*; the larvae of this beetle boring in the wood which has been penetrated by the mycelium of this fungus. Meyrick in his "Handbook of British Lepidoptera," mentions some seventeen species of *Tineidae*, the larvae of most of them being recorded as feeding on lichens.

Perris in "Larves de coléoptères," Paris, 1877 (Ann. Soc. Linn. XXII, XXIII) mentions *Tetratoma baudueri* in *Agaricus ostreatus* (p. 154), *Bolitophagus armatus* in *Boletus suberosus* (p. 116-7) and *Cis* living on branches infested by *Telephora* sp., (p. 65.) Ganglbauer in "Die Kafer von Mittel Europa, III" records *Liodes cinnamomea* in truffles (p. 209), *Agathidium seminulum* in *Trichia cinnaberina* (p. 241), *Diphyllus lunatus* Fab. in *Sphaeria concentrica* (p. 654), *Cryptophegus lycoperdi* in puffballs (p. 675), *Lathridius rugosus* on slime mould (myxomycetes) (p. 786), *Triphyllus bicolor* Fab. in *Fistulina hepatica* (p. 825) and *Lycoperdinen* on *Lycoperdon* and *Bovista* species (p. 912.)

The following records relate to species in this country which have been found to be associated more or less with polypores and gill fungi.

SLUGS

Limax maximus L. Sometimes eats ragged holes in caps of cultivated mushrooms. (Popenoe, U. S. D. A. Farmers' Bull. 789.)

SOWBUGS

Armadillidium vulgare Lat. Greenhouse pillbug. Sometimes feeds on caps of cultivated mushrooms (Popenoe, loc. cit.)

Porcellio laevis Koch. Dooryard sowbug. Sometimes feeds on caps of cultivated mushrooms. (Popenoe, loc. cit.)

ORTHOPTERA

Ceuthophilus pacificus Thom. Reported as eating into caps of cultivated mushrooms on Pacific Coast. (Popenoe, loc. cit.)

*Proc. Biol. Soc. Wash., vol. 33, pp. 1-20; vol. 34, pp. 59-62; vol. 34, pp. 85-88; vol. 34, pp. 167-72.

DIPTERA

Family *Phoridae*

Aphiochaeta albidihalteris Felt. Injurious to cultivated mushrooms. (Popenoe)
Sciara multiseta Felt. Injurious to cultivated mushrooms. (Popenoe)
Sciara agraria Felt. Injurious to cultivated mushrooms. (Popenoe)

COLEOPTERA

Family *Staphylinidae*

Philonthus cyanipennis Fab. Feeding on *Russula* sp. Lakehurst, N. J., June 30.
Tachinus fimbriatus Grav. Feeding on *Russula* sp. Lakehurst, N. J., June 30.
Boletobius cinctus Grav. Feeding on *Russula* and *Collybia* sp. Lakewood, N. J., June 30.

Family *Scaphidiidae*

Scaphisoma suturalis Lec. On *Clavaria* sp. Monmouth Jc., N. J., August 6.

Family *Nitidulidae*

Psilopyga nigripennis Lec. Occurs in the stink horn fungus. (Col. Ind. p. 646)
Psilopyga histrina Lec. Occurs in the stink horn fungus. (Col. Ind. p. 645)
Pocadius helvolus Erichs. Occurs in *Lycoperdon giganteum*. (Col. Ind. p. 644)
Carpophilus antiquus Mels. On the black fungus on ears of corn. Clementon, N. J., August 10. (Smith, Ins., N. J., p. 271)

Family *Erotylidae*

Tritoa biguttata Say. Feeding on *Russula* and *Collybia* sp. Lakehurst, N. J., June 30.

Family *Tenebrionidae*

Platydema ruficorne Sturm. Feeding on *Russula* and *Collybia* sp. Lakehurst, N. J., June 30.

Family *Anobiidae*

Dorcatoma setulosum Lec. Breeding in old *Polyporus cuticularis*. East Millstone, N. J., April 7.
Eutylistus tristriatus Lec. Breeding in old *Polyporus cuticularis*. East Millstone, N. J., April 7.

Family *Cisidae*

Plesiocis cribrum Csy. Breeding in *Polyporus volvatus* on pine stump. Lakehurst, N. J., June 30.

AN UNDESCRIBED PLANIDIUM OF PERILAMPUS FROM CONOCEPHALUS (HYM.)

BY NORMA FORD,

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An interesting phase in the life history of parasitic Hymenoptera, of comparatively recent discovery, is the occurrence of the "planidium" stage of certain Chalcidoid genera, notably *Perilampus, Psilogaster* and *Orasema*. The life histories in which this stage appears are suggestive of the oil beetles (Meloidae) which hatch from the egg as free-living larvae, seek their host, and then become parasitic and helpless.

The first discovery in connection with this type of life history in the Chalcidoidea was made by Prof. Wheeler (1907). While engaged in studying the life history of *Orasema viridis* Ashmead, a parasite of the harvesting ant (*Pheidole instabilis* Emery), he found proof of an early free-living stage. This stage he termed the *planidium*, from the Greek meaning a diminutive wanderer. *Orasema* belongs to the Eucharidae, a family closely related to the Perilampidae. The Eucharidae are parasitic upon ants. The planidium in this case is less than 0.1 mm. in length. Prof. Wheeler found it difficult to determine the number of body segments, because of the telescoping, but he stated that there are probably thirteen. The head segment bears short mandibles and the terminal segment has a pair of caudal setae.

In 1912 H. S. Smith ('12) found the planidium of *Perilampus hyalinus* Say as a secondary parasite of the tachinid and ichneumonid parasites of the fall webworm. The planidium was less than 0.3 mm. in length, oblong in shape, and dark brown in color. It was highly organized with a distinct head, 12 body segments, well-defined mouth parts, strong curved mandibles. The head was armed with curved hooks; the most of the plates bore pairs of bristles and ventrally there were projecting spines, the latter evidently functioning in locomotion. There were no legs.

In tracing out the life history, Smith found the planidia in the earliest stages on the exterior of the fall webworm, later within their bodies whether they were infested by primary parasites or not. Still later the planidia were endoparasitic within the larvae of the parasites, and finally ectoparasitic after the larvae had left the fall webworms and pupated. How the planidia came to be located upon the skin of the caterpillars, and where the eggs are laid, have not been ascertained. It is thought that the eggs are laid on the leaves of plants in the vicinity of a caterpillar colony.

In the course of his investigations, Smith found a second species of planidium which he was unable to rear, and which he terms *Perilampus* "species A."

In 1915 Thompson described a planidium which was attached to the integument of a Noctuid, feeding on witch-hazel. This species of planidium is slightly larger, being 0.35 mm. by 0.13 mm. A most important difference is that this form has fourteen segments. The details of structure are also quite different, and as follows: The dorso-lateral plates which do not extend over the ventral surface, terminate abruptly. The setae arise dorsally from the intersegmental membrane, not from the plate, although there are unchitinized spots on the plates, which, however, do not give rise to setae. The ventral setae and spines show an arrangement quite different from *Perilampus*. In the head segment Thompson was able to follow in some detail the mouth parts, figuring and describing the epipharynx, superior and inferior lips, mandibles, maxillae and palpi. Dorsally on the head he identified a pair of antennae.

In 1919 Prof. Brues briefly described from a cast skin the planidium of *Psilogaster fasciiventris* Brues, a member of the Eucharidae and a parasite of the Australian Bull-dog Ant, *Myrmecia forficata* Fabr. Prof. Brues does not figure the planidium, but he states that it is similar to that of *Perilampus*. In fact he says that this stage of *Psilogaster* is almost as close to that of *Perilamp-*

us hyalinus as the latter is to *Perilampus* "species A," figured by Smith. Prof. Brues suggests that it may be possible that "species A" is not a true *Perilampus,* as Smith did not succeed in rearing an adult.

While investigating a problem on the musculature of the Orthoptera, as post-graduate work with Prof. E. M. Walker, specimens were found parasitized by planidia. In this case the planidia were within the bodies of one of the small green grasshoppers, *Conocephalus fasciatus* (De Geer) (*Xiphidium fasciatum*). The Conocephali had been collected on September 14, 1921, in the Muskoka district at Port Sydney, Ontario. Out of nine specimens, six were parasitized. The planidia from *Conocephalus* are very similar to those of *Perilampus hyalinus,* resembling this species more closely than the planidia of the unknown "species A," or of the Noctuid or of *Orasema.* A careful comparison with the figures of *Perilampus hyalinus,* however, reveals distinct difference from that species.

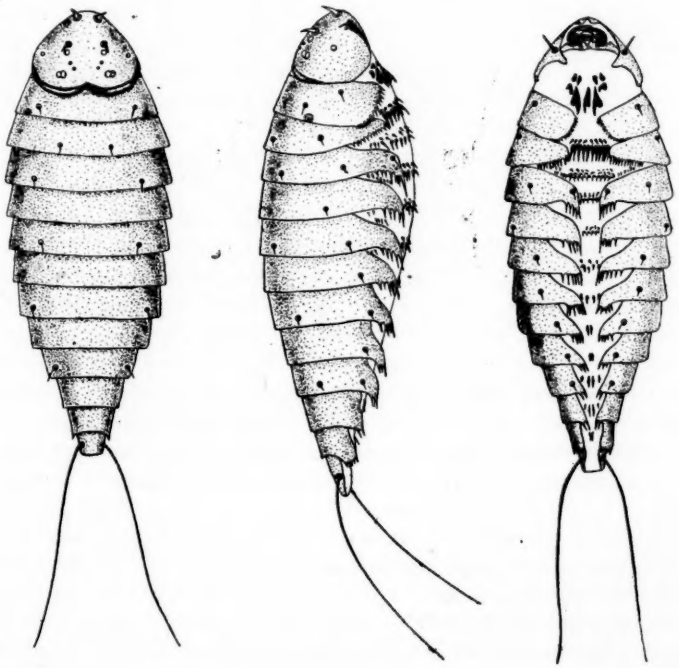

Fig. 1—Planidium of *Perilampus* from *Conocephalus.* From left to right, dorsal, lateral and ventral views.

The planidia from *Conocephalus* average 0.21 mm. in length, and 0.07 in diameter. Measurements of eight specimens were as follows: 0.23 x 0.07, 0.21 x 0.06, 0.19 x 0.08, 0.20 x 0.07, 0.20 x 0.06, 0.22 x 0.07, 0.21 x 0.07, 0.16 x 0.04 mm. The body is composed of thirteen segments, dark brown in color. The head segment is emarginate posteriorly and bears two pairs of recurved hooks. The posterior pair correspond to the structures which Thompson identified as an-

tennae, but in this species they are merely pointed hooks. Behind each hook of the posterior pair is a semi-transparent spot, followed by two smaller spots and then by a pair of large contiguous spots. There is also, on either side of the head, a lateral spot and a ventral-lateral hook.

The mouth-parts are difficult to determine. It would seem that the large curved mandibles are supported by a cross-bar of heavy chitin and that a distinct mouth-tube is present. Between the mouth-tube and the mandibles project forked structures which are probably maxillae.

Each body segment consists of a heavily chitinized tergite with a toothed ventral border and of an unchitinized sternal region provided with strong re-curved hooks. On the tergites are semitransparent spots each bearing a seta. These spots have a definite arangement in two rows—a dorsal and a ventral. The spots of the dorsal row are dorso-lateral in position and situated on the odd segments, 1, 3, 5, 7, and 9 and also on segment 2. The pair of spots on segment 2 are again exceptional because of their more dorsal position. The ventral row consists of spots ventro-lateral in position and situated on consecutive segments, 1, 2, 3, 4, 5, 6, 7, 8 and 9. An exception is found in segment 3 where the spots lie in a more ventral position and there is a third pair of spots situated on the extreme ventral portions of the tergite.

The two spiracles open dorso-laterally in the membrane connecting segments 1 and 2.

In the sternal region are groups of hooks segmentally arranged. The hooks of segment 1 are the largest and are arranged in two rows. Three hooks in the posterior row are much larger than the others, are attached by broad bases and taper into sharp re-curved points. Lateral and anterior to these are smaller hooks, varying in number in the anterior row from 3 to 5. In segment 2 the number varies from 8 to 9 in the anterior row and from 11 to 12 in the posterior row. In the remaining segments the number of hooks gradually decreases. The caudal setae are about six times the length of the last segment.

Comparing the planidium from *Conocephalus* with the planidium of *P. hyalinus*, the noteworthy points of difference are as follows: The planidium of *hyalinus* is larger and more slender, averaging 0.3 mm. in length and 0.06 mm. in diameter at the widest place, (as compared with 0.21 mm. in length and 0.07 mm. in diameter). The head segment lacks the lateral pair of semitransparent spots and ventro-lateral hooks. The dorsal row of spots on the tergites is similar in the two forms, but the spots of the ventral row on *P. hyalinus* extend only to segment 8, and in addition segment 8 bears a third pair of ventral spots, while on segment 3 the third pair is lacking. The spiracles are ventral in *hyalinus* instead of dorso-lateral, and the caudal setae are only twice the length of the last segment.

The planidium of "Species A" is quite different in structurural details from those just considered. The head segment is not emarginate, the ventral borders of the tergites are not toothed, the ambulatory spines are much less developed. The spots of the dorsal row on the tergites have a different arrangement being on segments 1, 2, 3, 4, 5, 6, 8 and 10, while those in the ventral row have an arrangement similar to that of the planidium from *Conocephalus*, being on con-

secutive segments, 1, 2, 3, 4, 5, 6, 7, 8, and 9, with a third pair of spots on segment 3.

Of the six parasitized specimens only one has been fully dissected. Seven planidia were found in the body, one lying in the connective tissue of the mesothorax, a second embedded in the sternal muscle of seg. 4, a third lying near the nerve cord in seg. 6, a fourth in the connective tissue near the intestine in seg. 6, while the fifth, sixth and seventh were in the sternal muscles of seg. 7. Smith found the planidia in almost any position in the caterpillar's anatomy, although they generally floated out freely in the body cavity. If the planidia also floated freely in the body of *Conocephalus*, many may have been lost since the speciments had been opened and pinned ready for musculature dissections and then preserved in alcohol.

It is quite improbable that the true host of *Perilampus* is *Conocephalus*. It would seem rather that the planidium must require some parasite of *Conocephalus* in which to complete its development. This view is supported first by the fact of the life history of *P. hyalinus* and *Orasema*. The planidium of *P. hyalinus* lives at first within the body of the dipterous or hymenopterous host, but does not feed. When the host changes into the pupa, the planidium then emerges, lives ectoparasitically and commences to feed, protected by the puparium or the cocoon. The planidium of *Orasema* lives entirely ectoparasitically upon the pupae of soldiers, males or females of the harvesting ant, where the young planidium is usually found attached to the intersegmental membrane near the head.

Comparing the life history of *Perilampus* and *Orasema*, it is evident (as Thompson pointed out), that the stage spent by *Perilampus* in the body of the fall web-worm and the host is merely a prolongation of the migratory period in the life of the planidium, since the parasite neither grows nor feeds and can not complete its development until it becomes ectoparasitic.

In view of these facts of life history it is quite improbable that *Conocephalus* is the true host, for a development comparable to those just described would be impossible. One would expect that the planidium is seeking in the body of *Conocephalus* the larva of some parasite of the latter. As evidence for this theory we searched for records of the parasites of Orthoptera. In 1910 Swenk ('11) reared *P. hyalinus* from an undetermined sarcophagid which in turn was reared from *Melanoplus bivittatus*. In 1914 an important paper was published by Kelly (1914) based on his investigations of the sarcophagid parasites of grasshoppers. As hosts he found *Schistocerca americana, Melanoplus atlanis, M. femur-rubrum, M. bivittatus, M. differentialis* and *Dissosteira longipennis*. As an example of his records he states that in June 1913 there was quite a serious outbreak of grasshoppers, the prevalent species being *Melanoplus differentialis, M. bivittatus* and *M. atlanis*, with a few scattering individuals of other species. "The ground was strewn with dead nymphs and adults of the three species mentioned, which had died from parasitism of sarcophagids, their bodies being alive with maggots, while the fields were literally swarming with these flies engaged in striking adults and nymphs of each instar, except the first. Deposition of the larvae by the sarcophagid took place only while grasshoppers were flying or hopping." This last observation is important as evidence that it is not the

dead bodies that flies attack. Kelly demonstrated that the sarcophagid flies will strike at any moving object—at moths, butterflies, cicada or a piece of crumpled tissue paper. He threw into the wind such a paper and no less than six flies struck it. When the paper was examined, two tiny maggots were found clinging to it. From some 800 dead grasshoppers collected nearly 1,200 *Sarcophaga* of several species issued.

Kelly also observed four species of *Sarcophaga* ovipositing on the adults and nearly grown nymphs of *Chortophaga viridifasciata*, during late April and early May. Adults of these species of parasites issued from the first week in June till the first week in July. It was judged that there are probably five or six generations for the season.

Kelly reared *Perilampus hyalinus* as a secondary parasite from the Sarcophagids.

Many records from numerous observers are brought together in Kelly's paper, and although there are no records of the Sarcophagids being reared from the long-horned grasshoppers, yet is is probable that they too are parasitized.

Regarding the planidium from *Conocephalus*, we shall attempt this summer to investigate its life history further and hope to rear the adults. In following out this work I am much indebted to Prof. E. M. Walker for his advice and help. I wish also to thank Dr. L. O. Howard and Mr. S. A. Rohwer for references in the bibliography.

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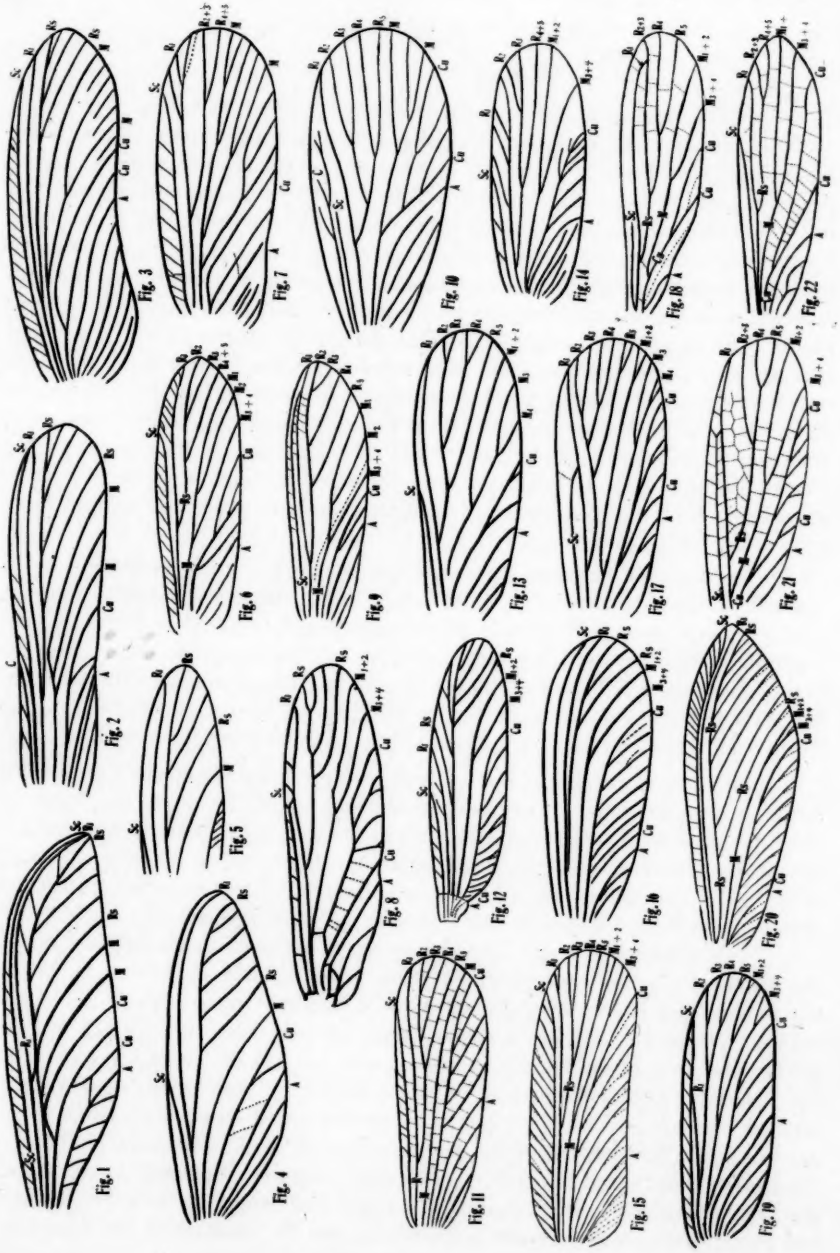
APPOINTMENT TO ENTOMOLOGICAL BRANCH, OTTAWA.

Canadian Entomologists will be pleased to learn of the appointment of Mr. C. H. Curran of Orillia, Ontario, to the position of Assistant Entomologist in the Division of Systematic Entomology, Entomological Branch, Ottawa. Mr. Curran, who has a well-earned reputation as a specialist in the Syrphidae, will have immediate charge under Dr. McDunnough, of the Diptera in the Canadian National Collection. A. G.

CAN. ENT. VOL. LIV. PLATE 5.



VENATION OF INSECT WINGS.

NOTES ON THE RELATIONSHIPS INDICATED BY THE VENATION OF THE WINGS OF INSECTS

BY G. C. CRAMPTON,

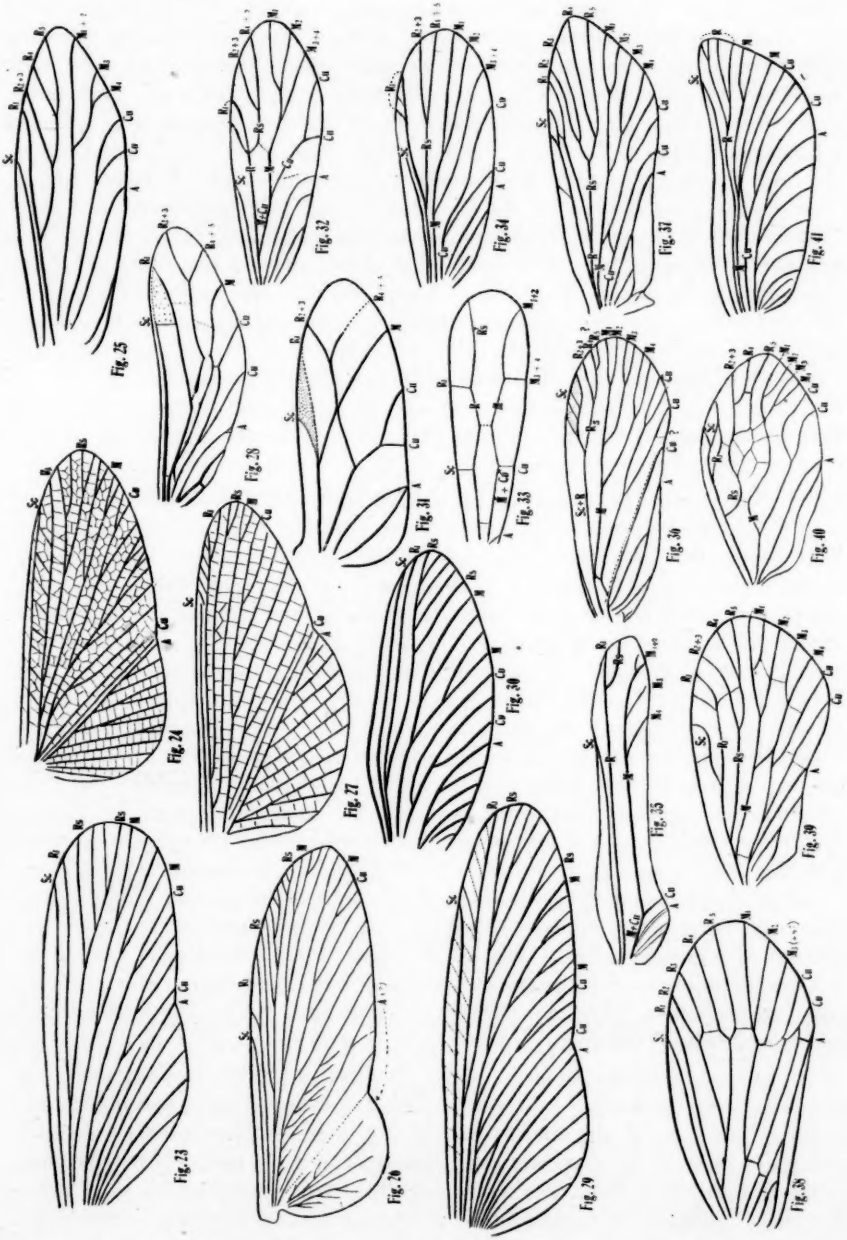
Massachusetts Agricultural College, Amherst, Mass.

Comstock and his students, and such investigators as Handlirsch, Tillyard, and others, have made available for comparison practically all of the more important types of wing-venation occurring in the different orders of insects; and in the following discussion, I would make use of the interpretations of the veins by these investigators, to point out wherein the evidence of the wings figured by them would support certain conclusions concerning the origin and interrelationships of the insectan orders, which I have reached from study of the parts of the body in general. While I feel that the interpretations of the veins, particularly the cubital and anal ones, (and more rarely the median veins also) are not correct in some cases, I have, nevertheless, followed the interpretations given by these investigators in each case, since my sole purpose at this time is to point out the similarity between the wings of certain insects, in support of my contentions as to the interrelationships of these forms, based upon the structures of other parts of the body; and the interpretations here given will in most cases serve the purpose sufficiently well.

The Palaeodictyoptera are considered by most of the recent students of venation as the direct ancestors of all other Pterygotan insects, and Handlirsch even considers them as ancestors of the Apterygota also. While the Palaeodictyoptera have departed but little from the types ancestral to the rest of the Pterygota, I do not think that they represent the actual ancestors of all other winged insects, and I am more inclined to regard them as a primitive group which branched off at or near the base of the common Pterygotan stem.

The Protodonata, (fig. 62) which are a primitive Odonatan type leading to the modern Odonata, are regarded as a distinct order by recent investigators, but I do not think that the character of the body in general of the Protodonata is sufficiently different from recent Odonata to justify placing them in a distinct order. The Protephemerida (fig. 63) on the other hand, seem to be different enough from their descendants, the Ephemerida, to be grouped in a distinct order. The Protephemerids and Protodonata are thought to be the descendants of the Palaeodictyoptera, but many of them have retained characters as primitive in some respects as the Palaeodictyoptera, and it is much more probable that the Protephemerida, etc., are descended from ancestors like those of the Palaeodictyoptera, rather than that the Protephemerida etc., are the direct descendants of the Palaeodictyoptera themselves. Certain immature Ephemerids exhibit characters extremely like those of *Lepisma, Machilis,* and other Apterygota which have departed but little from the condition typical of the ancestors of the first Pterygotan insects, and in many respects these immature Ephemerids are among the most primitive known Pterygotan forms. The wings of both Protodonata and Protephemerida are usually polyneurous, and the venation in the Protodonata in particular tends toward the unilateral type of branching. The venation of the Protephemerida, however, is not as similar as one might expect, and the

CAN. ENT. VOL. LIV. PLATE 6



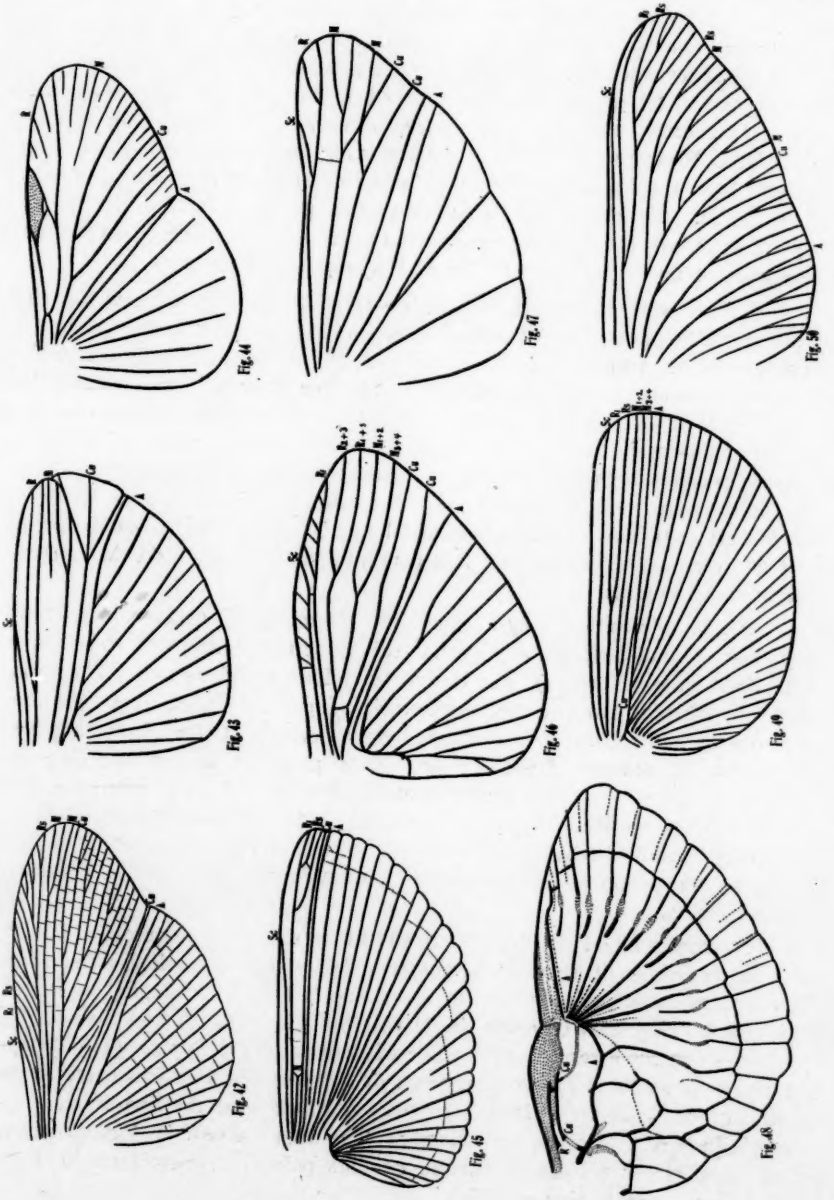
VENATION OF INSECT WINGS.

relationship between the two groups is not as close as is maintained by some investigators, nor does either type of venation approach that of the Plecoptera to any marked degree, so that the grouping of the Plecoptera with the Odonata and Ephemerida on the basis of their immature stages being aquatic, is a very artificial one, and apparently has no real phylogenetic significance. The venation of the Protodonata (and to some extent that of the Protephemerida) is rather suggestive of that of the Neuroptera in some respects, but the resemblance in this case is probably due to their mutual relationship to the Palaeodictyoptera. The lines of development of the Protodonata and Protephemerida apparently branched off at a very early period in the evolution of the Pterygotan types, and neither seems to be of any great value in the study of the evolution of the other Pterygotan types. The Protodonatan-Odonatan line of descent in particular is a very isolated one, leading along a path of specialization which does not approach very closely to that of any other group of insects, although the Protephemerid-Ephemerid line of development probably represents their nearest of kin (other than the Palaeodictyoptera), and the slight resemblance of the venation of both groups to that of certain Neuroptera is doubtless the result of convergent development.

The common ancestors of the Protoblattids and Protorthoptera are perhaps the most important of all insects for a study of the evolution of winged insects in general, since these two types exhibit many tendencies which were apparently carried over in the lines of development of the higher forms (so far as the wing venation is concerned) and a surprisingly large number of lower types apparently parallel their lines of development. If the hypothetical common ancestral stock from which the slightly diverging lines of the Protoblattida and Protorthoptera were descended be designated for convenience as the "Prodictyoptera," it would appear that the ancestors of these "Prodictyoptera" were related to the Protodonata and Protephemerida as well as to the Palaeodictyoptera, but their closest affinities were apparently with the Palaeodictyoptera. The Protoblattida are apparently somewhat nearer to the common ancestral stock than the Protorthoptera are, and the polyneurous tendency is the strongest in the Protoblattida, while many of the so-called Protorthoptera are markedly oligoneurous (if all of the forms called "Protorthoptera" by Handlirsch are really Protorthoptera—which seems very doubtful), and are quite highly specialized in their venation for such ancient insects. The wings of both Protoblattida and Protorthoptera are usually markedly "heteronomous," and in the hind wings of these forms (figs. 23, 29, 24, etc.) the precursor of the huge anal fan of the Orthopteroid insects makes its appearance.

Not only does the common ancestral stem of the Protorthoptera and Protoblattida form the central point about which the ancestors of recent insects are gathered, but many of the lines of descent of the earlier fossil orders are clustered about these forms, and their lines of descent in many instances parallel that of the Protorthoptera (and to a less degree that of the Protoblattida also) rather closely. Thus, the Synarmogoida (fig. 3) approach the ancestors of the Protorthoptera in many features, while they are clearly like the Palaeodictyoptera in other features. The character of the subcosta (Sc), radius one (R_1), and the

CAN. ENT. VOL. LIV. PLATE 7.



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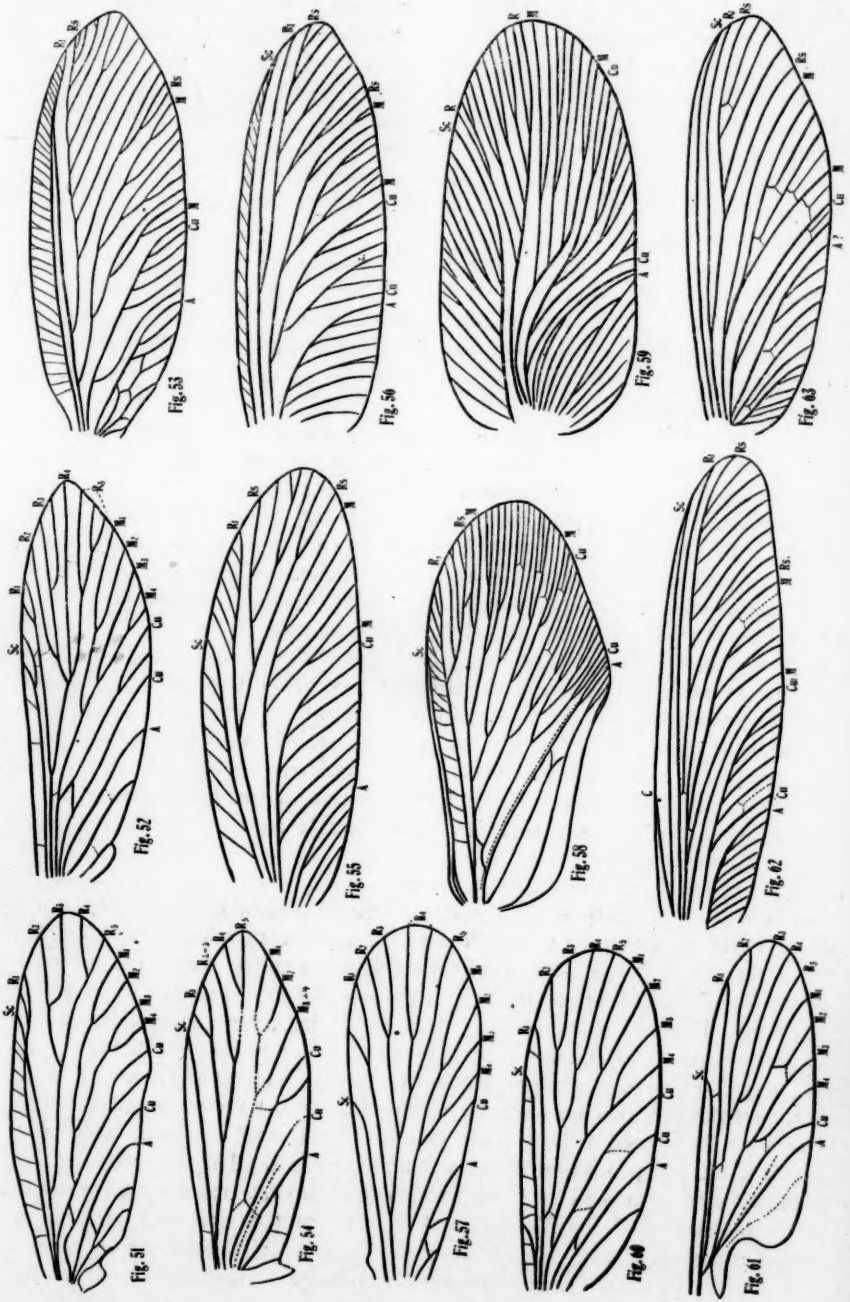
radial sector (Rs) of Fig. 3 clearly suggests affinities with the Orthopteron shown in Fig. 2, while media and cubitus of Fig. 3 are like these veins in certain Protorthoptera—although the latter veins are more like those of the Palaeodictyoptera than those of the Protorthoptera. The character of the anal veins in Fig. 3 are as much like those of the Protorthoptera (and Protoblattids) as any insects, and taking their venation as a whole, the wings of the Synarmogoida would indicate that their line of descent arose near the base of the common stem of the Protorthoptera and Protoblattida at the point where these forms diverged from the Palaeodictyoptera, in emerging from their common ancestry. While the line of descent of the Synarmogoida parallels that of the Protorthoptera in certain respects, the Synarmogoida are a more or less isolated group of no great value for the study of the evolution of recent insects.

The venation of the Hapalopteroida as shown in Fig. 9 resembles that of the Protorthoptera and Orthoptera shown in Figs. 6 and 2 quite closely. It likewise exhibits certain points of similarity to the Mixotermitoid shown in Fig. 13, and there is also a slight resemblance to the Plecopterous wing shown in Fig. 8, but the Hapalopteroid line of descent is apparently a rather isolated one having no great value in tracing the lines of descent of recent insects. The Hapalopteroida possibly branched off from the base of the common Protorthopteron-Protoblattid stem near the point where the latter began to diverge from the Palaeodictyoptera, and the Hapalopteroid line of development parallels that of the Protorthoptera rather closely, and also approaches that of the Mixotermitoida in some respects.

The Mixotermitoida (figs. 13 and 17) resemble the Protorthoptera (figs. 6, 19, and 2) quite closely, and they also exhibit certain features of resemblance to the Hapalopteroida (fig. 9) and to the Reculoida (fig. 7) as well. There is a slight resemblance to the Hadentomoida (fig. 21) also, but the resemblance is not marked. The closest resemblance is to the Protorthoptera, and the line of descent of the Mixotermitoida probably sprang from a point near the base of the common Protorthopteron-Protoblattid stem, where the latter began to diverge from the Palaeodictyoptera, and the Mixotermitoid line of development parallels that of the Protorthoptera and Hapalopteroida as closely as any. The group is of no particular interest for the study of the evolution of recent insects.

Practically all of the features exhibited by the Sypharopteroida (fig. 4) occur in the wings of some Protorthoptera (such, for example, as the short subcosta, long radius, one unilaterally branching radial sector, single-"branched" media, etc.) They also resemble the Mixotermitoida (fig. 13) and Megasecoptera (fig. 1) in some respects. The line of descent of the Sypharopteroida apparently arose at the point of divergence of the common Protorthopteran-Protoblattid group from the Palaeodictyoptera, and paralleled the line of development of the Protorthoptera very closely. The fossil shown in Fig. 5, which Tillyard regards as a Protorthopteron, exhibits points of resemblance to both Protorthoptera and Sypharopteroida.

The wing of the Hadentomoid shown in Fig. 21 is somewhat like that of the modified descendant of the common Protorthopteron-Protoblattid stem,



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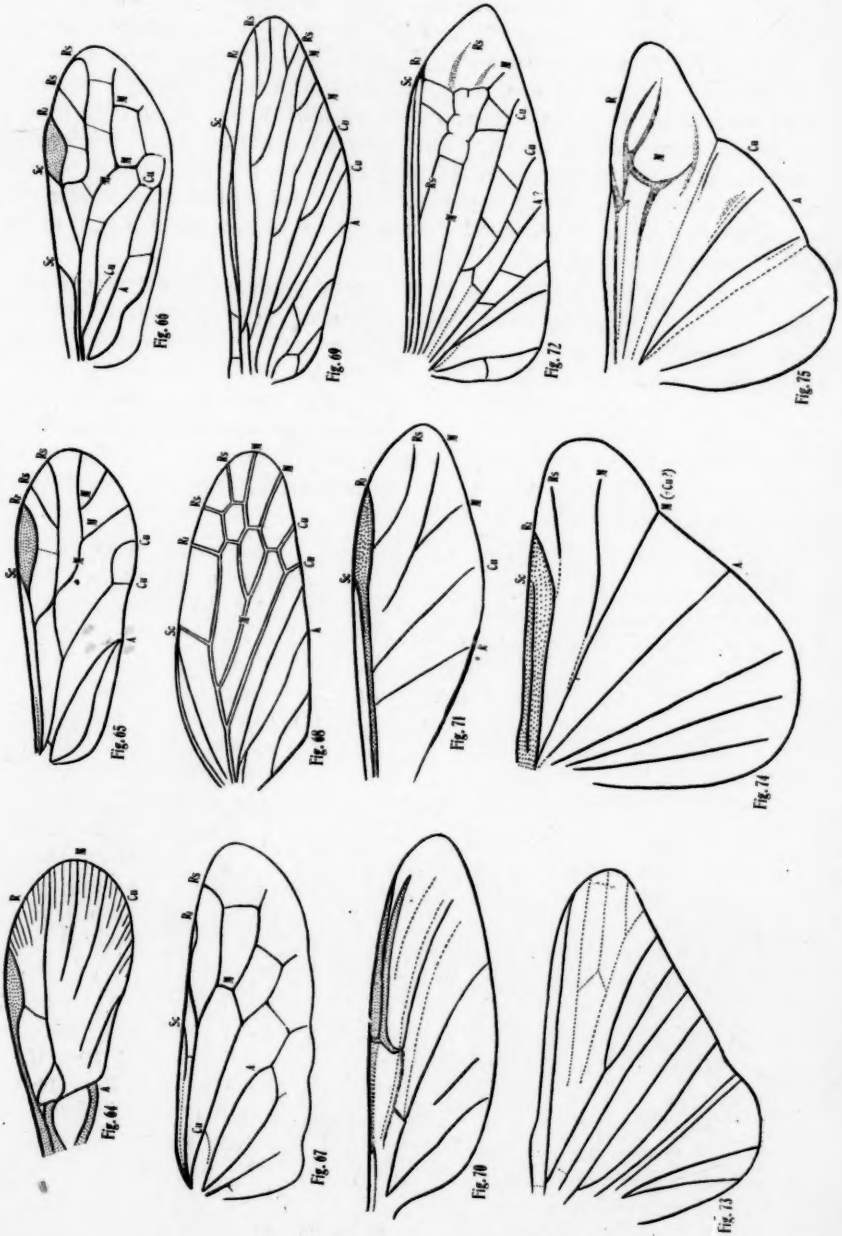
shown in Fig. 14, and it is also faintly suggestive of the Mixotermitoida (figs. 13 and 17) and Hapalopteroida (fig. 9) in some respects. It is somewhat more like the Protorthopteron *Lepium* (not figured here) however, and the Hadentomoida probably arose near the base of the common Protorthopteron-Protoblattid stem at the point where the latter diverged from the Palaeodictyoptera. The Hadentomoida exhibit certain features suggestive of a relationship to the Plecoptera (figs. 22 and 8), and also to the Embidiina (fig. 18), so that their line of development is of some interest for the study of the evolution of certain recent forms.

The Reculoida (fig. 7) resemble the modified descendant of the common Protorthopteron-Protoblattid stem shown in Fig. 10, and they also resemble the Protorthoptera (fig. 6) quite closely. Their line of descent probably branched off near the point of divergence of the common Protoblattid-Protorthopteran stem from the Palaeodictyoptera, and their line of development parallels that of the Protorthoptera fairly closely.

The wing of the Megasecopteron shown in Fig. 1 is perhaps as much like that of a Palaeodictyopteron (fig. 30) as any other, but it clearly approaches the Protorthopteran and Orthopteran types (fig. 2) in the tendency for media to unite with the radial sector, and for cubitus to unite with media. The Megasecoptera resembles the Sypharopteroida (fig. 4) in certain respects, and they also bear a rather faint resemblance to the Protephemerids and Synarmogoida (fig. 3) in certain features, but their closest affinities are with the Palaeodictyoptera and Protorthoptera, and their line of development apparently arose near the point where the Palaeodictyoptera began to diverge from the common ancestors of the Protorthoptera and Protoblattida, and paralleled the line of development of the Protorthoptera rather closely, while it approached the lines of development of the Sypharopteroida and Synarmogoida only slightly. Since certain tendencies observable in the Megasecoptera find opportunity for fuller expression in the Neuropteroid insects, the study of the Megasecoptera is of considerable value in tracing the origin of the higher insects.

In taking up the consideration of the evolution of recent insects, we find that here also, the study of the venation of the Protoblattida and Protorthoptera is of prime importance, as was likewise the case in studying the evolution of the earlier fossil forms, since the lines of development of recent forms as well as the earlier fossil types, tend to group themselves about the Protoblattida and Protorthoptera, which, judging from their wings, were a variable group in an active state of evolution. I have grouped the recent orders Blattida, Mantida and Isoptera into a single superorder (the "Panisoptera"), and I would point out the fact that the evidence of the venation of the wings is in full accord with that drawn from a study of other features of the body, which indicate that the group mentioned above is a natural one. The wings of the Protoblattida clearly indicate that the Protoblattids are the nearest representatives of the precursors of the Blattida, and if one compares the hind wing of the Mantid shown in Fig. 27, with that of the Protoblattid shown in Fig. 24, it is quite evident that the Protoblattids are the nearest representatives of the precursors of the Mantids also; and both Blattids and Mantids apparently arose



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from the same source in the common Protoblattid-Protorthopteron stock. Similarly, the hind wing of the Isopteron shown in Fig. 26 is very similar to that of the Protorthopteron shown in Fig. 29, and also resembles extremely closely the hind wings of the Protoblattid shown in Fig. 23. The Isoptera, therefore, in all probability arose from the same source in the common Protoblattid-Protorthopteron stock which gave rise to the Blattids and the Mantids. Although the alaflabellum, or anal fan, of the Isopteron shown in Fig. 26 is not typical of all Isoptera, the termite there figured is a very primitive one, and its condition clearly indicates that certain of the ancestral Isoptera had well developed alaflabellum, which they evidently inherited from ancestors of the common Protorthopteron-Protoblattid stock.

The precursor of the anal fan of the Protoblattids and Protorthoptera is suggested by the broadening of the basal portion of the hind wings of such Palaeodictyoptera as the one shown in Fig. 50, but it is not very probable that this Palaeodictyopteron represents very closely the type which gave rise to the common Protorthopteron-Protoblattid stock. The alflabellum is enormously developed in the Orthopteroid descendants of the Protorthopteron-Protoblattid stock (figs. 48, 49 and 45) and it is also large in the Plecopteron shown in Fig. 46 (which was also derived from ancestors resembling the Protoblattids and Protorthoptera in many respects.)

I have grouped the Plecoptera and Embiidina in a common superorder (the "Panplecoptera"), and the venation of the wings would clearly support such a grouping, as may be seen by comparing the wing of the Plecopteron shown in Fig. 22 with that of the Embiid shown in Fig. 18. Both of these wings resemble that of the Hadentomoid shown in Fig. 21, rather closely, and the wings of the Plecoptera (figs. 22 and 8) are rather suggestive of the Hapalopteroida (fig. 9) in some respects. The Plecoptera, however, in all probability were derived from ancestors closely resembling the common Protorthopteron-Protoblattid stock (and also related to the Palaeodictyoptera) from which the Isoptera were descended, since the wing of the Plecopteron shown in Fig. 8 is extremely similar to that of the Isopteron shown in Fig. 12, and both lead back to the Protorthopteron-Protoblattid types shown in Figs. 19, 11, 15, etc. If the termite-like insect shown in Fig. 16 is really a Neuropteron, the venation of some Neuroptera evidently approach the type of Isopteran and Plecopteran venation shown in Figs. 12 and 8, thus suggesting that the origin of the Plecoptera was not far from the point of origin of the Neuroptera also. The huge anal development in the hind wing of the Plecopteron shown in Fig. 46 would indicate that the primitive Plecoptera sprang from the same stock which gave rise to such Blattids as the one shown in Fig. 42 (and 43), thus lending further weight to the view that the common Protorthopteron-Protoblattid stock represents quite closely the ancestors of the Plecoptera (and their allies the Embiidina), and the lines of development of the Plecoptera and Embidiina parallel those of the Protorthoptera and Protoblattida quite closely, while they approach the Hadentomoida and Hapalopteroida only slightly. It should be borne in mind that the Embiid type of wing approaches the Isopteron type almost as closely as the Plecoptera mentioned above do, but it has not seemed necessary to include fur-

ther figures to demonstrate this fact, since it is quite patent that the Embiidina and Plecoptera are so closely related that what applied to one applies to the other, as well.

The Dermaptera, Phasmids, Grylloblattids, and saltatorial Orthoptera are here grouped in the superorder "Panorthoptera." The Dermaptera were formerly grouped with the Embiidina and Plecoptera, but it is preferable to place them nearer the Phasmids, saltatorial Orthoptera, etc., than was done in the former grouping. In the enormous development of the anal area, and the accompanying reduction of the preanal region (i. e. the region in front of the anal area) the Dermapteron wing shown in Fig. 48 approaches the Orthopteron and Phasmid shown in Figs. 45 and 49, and the "floating" or intercalary veins, which are not attached basally, and occur between the anal veins (of which they are probably detached branches), are rather similar in the insects in question. The paramarginal line extending almost parallel to the margin of the wing in the insect shown in Fig. 48, was possibly formed by the joining, end-to-end, of certain of the cross veins, some of which are shown in Fig. 45. The wings of the Dermaptera (Fig. 48) likewise approach the Blattid wings shown in Figs. 43 and 44, and they are also suggestive of the wing of the Plecopteron shown in Fig. 46. From these resemblances, we may conclude that the Dermaptera arose from the common Protorthopteron-Protoblattid stem very near the point at which the lines of development of the Phasmids and saltatorial Orthoptera branched off, but the general character of the body in general would preclude the possibility of deriving the Dermaptera from saltatorial Orthoptera. It is likewise very probable that the line of development of the Dermaptera arose near the point of origin of that of the Blattids and of the Plecoptera (with the Embiidina) as well, and this would account for the general resemblance of the Dermaptera to the Plecoptera and Embiida, as well as to the Blattids, Mantids and Isoptera, since they all arose near the same point, though the line of development of the Dermaptera follows that of the Phasmids and saltatorial Orthoptera (with the Grylloblattids) more closely than any other forms. In this connection, it may be mentioned that the Hemimeridae are merely modified Dermaptera, and the Grylloblattids are probably very primitive Orthoptera closely related to the Protorthoptera and Protoblattids. The wings of the Phasmids (Fig. 49) would indicate that their closest affinities are with the saltatorial Orthoptera (Fig. 45), although in the general character of their external anatomy, they are extremely closely related to the Grylloblattids and Dermaptera, and likewise exhibit certain points of resemblance to the Plecoptera and Embiids, as well as to the Mantids, Isoptera, and Blattids (compare also the wings shown in Figs. 43, 42, and 46 with Fig. 49.) The Phasmids apparently sprang from the common Protorthopteron-Protoblattid stock very close to the point where the true Orthoptera (with the Grylloblattids) and Dermaptera arose, and also not far from the point of origin of the Blattids (with the Mantids and Isoptera) and the Plecoptera (with the Embiidina) also. The line of development of the Phasmids, however, parallels that of the saltatorial Orthoptera (with the Grylloblattids) extremely closely; and the wings would indicate that their closest allies are among the saltatorial Orthoptera and Dermaptera, and also that the Blattids are their next closest allies. The body in general of the Phasmids is much more primitive

than that of the saltatorial Orthoptera, and it is infinitely more probable that the Phasmids branched off near the base of the Orthopteran stem, than that the Phasmids were derived from the saltatorial Orthoptera.

(To be continued.)

THE PERMANENT BUREAU OF ALL-RUSSIAN ENTOMO-PHYTO-PATHOLOGICAL CONGRESSES IN PETROGRAD, RUSSIA.

The Permanent Bureau of All-Russian Entomo-Phytopathological Congresses, Liteyny, 37-39, Room 59, Petrograd, Russia, desires:

1. To *exchange printed matter* (published since 1914) on entomology, phytopathology, mycology and zoology, with American colleagues, Scientific Societies, Agricultural Experiment Stations, Museums of Natural History, periodicals, etc.

2. To receive from *American publishers catalogues* and specimen numbers of various publications on the above mentioned subjects.

3. To receive *catalogues* and price-lists from American firms dealing in various *apparatus and chemicals* used in combating the plant injurers.

The above mentioned Permanent Bureau has supplied credentials to Mr. D. N. Borodin (who also represents the Bureau of Applied Botany of the Russian Agriculatural Scientific Committee, Petrograd) to collect literature in this country and give all the necessary information to the American colleagues, concerning entomological work conducted in Russia, and to organize an exchange of literature.

Mr. Borodin will accept all packages with books, bulletins, etc. for Russia, if they will be addressed to him at No. 110 West 40th Street, Room 1603, New York City.

BOOK NOTICE

Volume X, No. 1 of the University of Iowa Studies contains three entomological articles.

I. Report on the Scutelleroidea collected by the Barbadoes-Antigua Expedition in 1918 by Dayton Stoner.

Seventeen species are recorded. The report is well illustrated and many interesting observations on the habits, food plants and distribution of the various species are given.

II. Report on the Orthoptera and Dermaptera of the same Expedition by A. N. Caudell.

Thirty-one species are treated of, distributed as follows:—Forficulidae, 2; Blattidae, 8; Mantidae, 2; Phasmidae, 2; Acrididae, 7; Tettigonidae, 3; Gryllidae, 7.

One new species of Blattidae, *Eurycotis similis*, one new Acridian, *Amblytropidia stoneri*, and two new Gryllids, *Cycloptilum minimum* and *Hetrecous? dubius* are described.

III. The Scutelleroidea of the Douglas Lake Region by Dayton Stoner.

Twenty-seven species are listed as occurring in the vicinity of this northern Michigan Lake and numerous valuable ecological notes are given under the various specific headings. J. McD.

Mailed Thursday, November 23rd 1922.